RESEARCH ON REGIONAL DIFFERENCES BETWEEN CHINA'S ECONOMIC GROWTH AND EXPORT TRADE BASED ON THE ANALYSIS OF A RANDOM EFFECTS MODEL

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ABSTRACT

This paper analyzes the factors that influence the economic growth of the provinces of China by means of a Panel Data Model. Traditional analytical methods of economic growth are compared with a Panel Data Model. The results of empirical research indicate that the changes of fixed assets investment, gross domestic export, and macroeconomic policies will affect China's GDP. It is finally concluded that export is the driving force behind economic growth in China. This conclusion is quite different from traditional analysis.

Keywords: Economic growth, Panel Data, OLS, Foreign direct investment, Dummy variables

1 INTRODUCTION

From the classical economist Adam Smith's theory of 'Vent for Surplus' to the modern 'Trade as the engine of growth' theory of Robert Son, the study of the relationship between international trade, export trade in particular, and economic growth has been a hot issue for economists (Alvarez & Molero, 2005; Guo, 2004). In the context of open economy, economists and governments have recognized export trade facilitating economic growth or export-led economic growth as a wise development strategy. This development concept is widely supported by the successful development practices of Asian emerging industrialized countries and regions, especially Hong Kong, Korea, and Taiwan.

Nowadays, in the studies that examine China's economic growth, co-integrated theory is used to analyze the relations between fixed assets investment and economic growth. When an individual province is taken as the subject, it is believed that the impact of fixed assets investment on economic growth has some obvious phased characteristics (Qiu, 2004). Data Envelopment Analysis (DEA) is adopted to prove that the economic growth in each Chinese province is attributed to material capital, human capital, technological advance, and transfer. By exploring the evolution of the distribution of economic growth in these provinces, it is discovered that the growth is gradually evolving into double peaks from a single peak, which means that the economic growth of China takes on the convergence of two peaks (Xu & Shu, 2004). Foreign trade plays a non-negligible role in the economic growth of a country; however, there has been divergence in the theoretical community on whether import or export is more important. In other words, there is divergence about the strength of the economic driving forces generated by the two aspects of foreign trade.

Some researchers use an individual province as the analysis subject, choosing data related to GDP and import and export to make a co-integrated analysis, developing the 'error correct model' of the three on the basis of the Granger Theorem and reaching the conclusion that import growth more greatly facilitates the economic growth of each province and then making further analysis on relevant causes (Wu & Chen, 2004). However, other researchers (Yi, Li, & Yang, 2004) believe that the integrated relation among GDP, export, and import is most important. Export growth is the Granger cause for economic growth, and so is import growth. That is to say, both export and import concurrently facilitate economic growth. In accordance with co-integration theory (Wang & Zhang, 2004), there is a causal relation between economic growth and foreign trade in China, and both import growth and export growth are the Granger causes for the growth of GDP in China over both long and short periods of time. Deng Fang (2004) uses the Error Correction Model (ECM) to prove that there is a close relation between GDP and export growth in our country over a short time, and while export growth greatly promotes the economy of our country, the impact of import growth on economic growth is not so obvious. This means that the economic growth in a short period of time is export-oriented.

This paper is organized as follows: Part I is the introduction, which raises questions and provides an overview of the theories related to foreign trade and economic growth as well as relevant documents. Part II presents model structures and the mode of analysis by region. Part III provides the data used in this analysis. Part IV analyzes the economic differences within China and draws some conclusions from the inertia of economic growth and trade level. The last part contains final conclusions.

2 MODEL AND METHODOLOGY

In economic analysis, a special variable is usually taken into consideration in the analytical models, that is, regional difference, which does not change with the progress of time. In this paper, three economic belts of China, the eastern, central and western regions, are analyzed to present the typical differences between provinces. The eastern economic belt includes 11 coastal provinces and municipalities: Beijing, Tianjin, Liaoning, Hebei, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, and Hainan. The central economic belt includes 8 provinces: Heilongjiang, Jilin, Shanxi, Anhui, Jiangxi, Henan, Hubei, and Hunan; and the western economic belt includes 12 provinces and municipalities: Xinjiang, Sichuan, Chongqing, Tibet, Yunnan, Qinghai, Gansu, Ningxia, Shaanxi, Guizhou, Guangxi, and Inner Mongolia. In this vast territory, great differences in development can be found among the regions of China for reasons such as history and reality. Even in the inner part of each region, the economic development levels also exhibit very large differences. In the 1950's, regional economists divided China into 7 economic zones: Northeast, Northwest, North China, East China, Central China, South China, and Southwest. More specifically, they are Liaoning, Jilin, and Heilongjiang (Northeast); Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang (Northwest); Beijing, Tianjin, Hebei, Inner Mongolia, and Shanxi (North China); Shandong, Shanghai, Jiangsu, and Zhejiang (East China); Henan, Anhui, Jiangxi, Hubei, and Hunan (Central China); Fujian, Guangxi, Guangdong, and Hainan (South China); and Sichuan, Guizhou, Yunnan, and Tibet (Southwest). When analyzing regional economic growth, this paper will analyze and calculate according to the latter model of regional divisions.

First of all, a descriptive statistical analysis on time series data of economic variables of more than 30 provinces, municipalities, and autonomous regions throughout the country discovers that there are more unusual value points in the economic variables of the Tibet Autonomous Region and that common insertion and supplementation as well as smoothing cannot reflect the missing data effectively. It is reasonable for us to doubt the authenticity and accountability of such statistical data. As a result, in the positive analysis of the paper, the Tibet Autonomous Region is removed from the samples of the western region and the whole country. Furthermore, until 1997 the data of Sichuan Province included the data of Chongqing Municipality. For the purpose of accurate measurement, the data of both Sichuan Province and Chongqing Municipality are eliminated. Thus the data of 27 provinces are obtained from such changes.

All the sequences represent the observed data of 27 provinces from 1995 to 2004. The sources of the data are mainly the *1995-2004 China Statistical Yearbook*, the State Information Center, and the China Economic Information Network Data Co., Ltd. For the convenience of calculation, current values of different periods are used without considering the impact of the price index. When processing data, the natural logarithm is used to eliminate heteroscedasticity. The exchange rate is the annual average conversion rate of RMB versus key foreign currencies, i.e. the annual middle price (1995-2004).

The study on regional differences in economic growth during a specific period includes cross section data and time series data. Only using time series data or cross section data will not meet the requirements for economic analysis. For example, the growth of the GDP in each province is influenced not only by the economic structure of the region but also by the macroeconomic policies of China during different periods. Cross section data (that is, choosing data from different provinces at the same time as sampled observed values) alone can only support analysis of the impact of different industrial structures in the provinces or municipalities on economic growth; however, time series data (that is, choosing data from the same province or municipality at different time periods as sampled observed values) can only analyze the impact of macroeconomic policies or structures (consumption, savings, investment, and net export) on a country's economic growth. Similarly, such analysis cannot discover the impact of structural differences among the regions' economic growth. As a result, the model adopted for the analysis is the Panel Data Model. This combines cross section data with time series data.

The formula of the general model for economic growth is given in Equation 1.

$$GDP_{it} = A(IN_{it})^{\alpha}(CON_{it})^{\beta}(EX_{it})^{\gamma} \qquad (1)$$

The logarithm used is given in Equation2.

$$\ln GDP_{it} = \widehat{\beta}_0 + \widehat{\beta}_1 \ln IN_{it} + \widehat{\beta}_2 \ln CON_{it} + \widehat{\beta}_3 \ln EX_{it} + e_{it} \qquad (2)$$

In the above formulas, GDP represents gross domestic product of the provinces; IN is the data of fixed assets investment; CON means consumption; EX refers to the export activity at the current period; IM means the import data of the current period. In addition, i represents the provinces and t the years.

The introduction of dummy variables (also usually called qualitative interpretation variables) can help find how economic change in each region is influenced not only by quantitative variables (e.g. export and fixed assets investment) at some clear sizes but also by qualitative variables (Asian Financial Crisis). For instance, under the same conditions and in case of the same factors, China's economic growth at the regional level will necessarily suffer negative influence when financial crisis occurs. Meanwhile, China's foreign exports will also be greatly affected.

The time period between 1995 and 2004 witnessed the Asian Financial Crisis and the local overheating of China's economy in 2003. These can be defined as follows:

$$D99 = \begin{cases} 1, & 1997\sim1999 \\ 0, & \text{other fiscal years} \end{cases} \qquad D03 = \begin{cases} 1, & 2003 \\ 0, & \text{other fiscal years} \end{cases}$$

In Equation (2), dummy variables are added to represent economic fluctuation, and D99 and D03 refer to dummy variables respectively as Equation (3).

$$\ln GDP_{it} = \widehat{\beta}_0 + \widehat{\beta}_1 \ln IN_{it} + \widehat{\beta}_2 \ln CON_{it} + \widehat{\beta}_3 \ln EX_{it} + \widehat{\beta}_4 D99 + \widehat{\beta}_5 D03 + e_{it} \qquad (3)$$

In accordance with the model, $\widehat{\beta}_0$ is used to interpret the differences in economic growth among the provinces, municipalities, and autonomous regions.

3 DATA

The growth rate of the GDP[1] for the provinces of China is used to represent the speed of their economic growth. For the convenience of analysis, we define the rate of actual economic growth of Province *i* in the years of 1995-2004 in Equation 4.

$$RGDP_{it} = \frac{GDP_{it} - GDP_{i(t-1)}}{GDP_{i(t-1)}} \qquad (4)$$

Similarly, RIN is defined as the growth rate of fixed assets investment; RCON: the growth rate of household consumption; and REX: the growth rate of export data at the current period. In addition, *i* represents the provinces and *t* the years in Equation (5).

$$RIN_{it} = \frac{IN_{it} - IN_{i(t-1)}}{IN_{i(t-1)}}; RCON_{it} = \frac{CON_{it} - CON_{i(t-1)}}{CON_{i(t-1)})}; \; REX_{it} = \frac{EX_{it} - EX_{i(t-1)}}{EX_{i(t-1)}}. \quad (5)$$

In order to eliminate the impact of price fluctuations, we divide the above by the 'index of gross domestic market value,' 'price index of fixed assets investment,' and 'price index of household consumption' (calculated by comparable price which is 100 in the previous year) (See the data in Table 1).

Table 1. Different Price Indices of Economic Growth in China (1995-2004)

Price indices	(previous year=100)		
Year	Index of household consumption	Index of fixed assets investment	GDP deflating Index[1]
1995	117.1	105.9	113
1996	108.3	104	106
1997	102.8	101.7	101

[1] GDP is usually calculated by its deflating index, with the formula below: GDP deflating index=100*GDP nominal growth rate/ GDP actual growth rate. As a result, the GDP index here refers to GDP deflating index.

1998	99.2	99.8	98
1999	98.6	99.6	98
2000	100.4	101.1	101
2001	100.7	100.4	101
2002	99.2	100.2	100
2003	101.2	102.2	102
2004	103.9	105.6	106

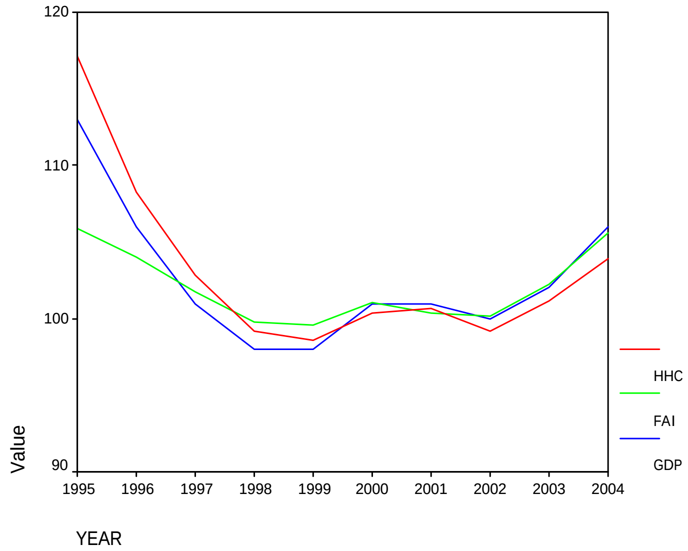

Figure 1. Different Price Indices of Economic Growth in China (1995-2004)

Then, the HHC is the representative index of household consumption; FAI is the representative index of fixed assets investment; and GDP is the representative index of the deflating index.

In order to make the dimensions of the data the same, the USD is adopted uniformly as the measurement unit, while the exchange rate is the annual average conversion rate of RMB vs. key foreign currencies, that is, the annual middle price (1995-2004) (See the data in Table 2).

Table 2. Annual Average Conversion Rate of RMB Vs. Key Currencies (Middle Price, 1995-2004) Unit: RMB yuan

Year	USD（100）
1995	835.1
1996	831.42
1997	828.98
1998	827.91
1999	827.83
2000	827.84
2001	827.7
2002	827.7
2003	827.7
2004	827.68

The following data are summarized from the GDP of 7 regions in China: Northeast: Liaoning, Jilin, and Heilongjiang; Northwest: Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang; North China: Beijing, Tianjin, Hebei, Inner Mongolia, and Shanxi; East China: Shandong, Shanghai, Jiangsu, and Zhejiang; Central China: Henan, Anhui, Jiangxi, Hubei, and Hunan; South China: Fujian, Guangxi, Guangdong, and Hainan; and Southwest: Sichuan, Guizhou, Yunnan, and Tibet (See the data in Tables 3-7).

Table 3. China's seven major economic regions' GDP

GDP 10,000 U.S. dollars	North China	Northeast	East China	South China	Central China	Southwest	Northwest
1995	848985.8	710944.8	1933295	1126089	1293085	219943.7	305141.9
1996	1018004.1	829596.35	2286797.3	1345938.3	1579833.3	265247.41	360266.77
1997	1155506.8	922269.54	2572898	1513061.8	1798310	294001.06	406335.5
1998	1255824.9	999184.69	2782651.5	1641635	1924078.7	318365.52	434275.46
1999	1324993	1055610	2990924	1744205	2009158	334319.8	462610.7
2000	1479984	1176948	3347586	1950971	2192110	356182.4	516308.7
2001	1641813	1283866	3702937	2135863	2386275	381733.7	567915.9
2002	1828954	1399843	4154714	2357283	2598149	412874.2	619179.7
2003	2152519	1565193	4898212	2623402	2886541	461689	720804.6
2004	2626374	1828428	5990963	3163235	3509230	549885.2	858161.2

Table 4. China's seven major economic regions' fixed assets investment

IN 10,000 U.S. dollars	North China	Northeast	East China	South China	Central China	Southwest	Northwest
1995	322250	203973.2	736904.6	429179.7	341260.9	66128.61	101793.8
1996	371001.42	218096.75	853946.26	457093.89	431295.86	78157.85	121650.91
1997	430860.82	243389.47	905635.84	459988.18	471385.32	91787.498	140904.49
1998	490285.18	272919.76	984898.12	535424.14	527419.65	113398.8	173997.17
1999	524727.6	286430.2	1023912	579252.5	542115.9	117886.3	193041.8
2000	565325.4	326612.6	1125870	608757.7	609928.2	130573.5	219484.4
2001	640094.2	372897.2	1262711	667668.2	692294.3	153976.1	257445.9
2002	742455	421161	1525265	734517.3	802519	174891.9	298251.8
2003	961979	508831.7	2149027	907442.3	1013012	211211.8	375969.6
2004	1236118	674415.2	2691161	1115806	1338730	254385.8	453689.8

Table 5. China's seven major economic regions' consumer activity

CON 10,000 U.S. dollars	North China	Northeast	East China	South China	Central China	Southwest	Northwest
1995	316202.8	328149.9	670977.1	497782.3	611941.1	121638.1	148975
1996	374594.07	375788.41	808004.38	609269.68	754226.5	146736.91	177515.58
1997	416487.73	417283.89	911541.89	666626.46	834073.2	161161.91	195927.53

1998	430179.61	435470.04	960019.81	694991	869611.43	168689.83	201579.88
1999	457316.1	462619.1	1026406	719036.5	904593.9	186439.2	210405.5
2000	516899.4	501497.9	1137309	783823	987026.5	201355.3	229355.9
2001	578869.2	544617.6	1259551	821094.6	1064347	186770.6	234082.4
2002	655464.5	584434	1390896	912801.7	1151115	201025.7	258599.7
2003	740527.7	625229.6	1574642	999009.3	1270829	211700.2	277063.6
2004	827336.1	672534.5	1740083	1074916	1373661	222144.3	295672.1

Table 6. China's seven major economic regions' exports

EX 10,000 U.S. dollars	North China	Northeast	East China	South China	Central China	Southwest	Northwest
1995	1732373	1067759	4185116	6965221	628384	139965	198585
1996	1730181	1068910	4184796	6965118	628211	139878	198548
1997	1987744	1139750	5021623	8788257	731020	157932	234348
1998	2055731	970936	5280898	8816795	667885	151789	247987
1999	2072811	1017579	6155329	9003291	650359	139230	274286
2000	2651095	1356433	8609075	10711557	845343	159565	325650
2001	2732988	1408208	9759424	11138526	857574	166583	260484
2002	3130794	1612170	12102102	13816013	951727	187154	356162
2003	4058000	1966000	17574000	17692000	1235000	227000	567000
2004	5616700	2431500	25501700	22443300	1658700	310600	708600

Table 7. China's seven major economic regions' imports

IM 10,000 U.S. dollars	North China	Northeast	East China	South China	Central China	Southwest	Northwest
1995	3257429	768569	2751480	5670852	376102	111208	128417
1996	2796693	793075	3468106	6006038	375036	93646	136147
1997	2735936	782617	3509895	6514701	338891	72885	121574
1998	2687447	670377	3640879	6295866	321872	76140	178383
1999	3339394	795317	4489483	7089913	384060	81539	175251
2000	4988999	1102394	6707601	8752542	453544	87709	216007
2001	5209651	1231618	7640216	9128299	569185	96940	254029
2002	5542000	1367000	9780000	11564000	638000	105000	267000
2003	7214000	1839000	15630000	14752000	967000	139000	387000
2004	10316700	2370700	22176300	18792900	1298000	215900	487400

4 REPORT AND ANALYSIS OF THE MODELS OF REGIONAL ECONOMIC GROWTH OF CHINA

Many economists use models such as Fixed Effects and Random Effects to evaluate regional economic growth; however, the two models are never used in relevant documents available in China. In this paper, we apply the two models to the evaluation of the 7 regions of China (Hsiao, 2003; Greene, 1997).The specific models are presented as follows: the Fixed Effects Model is given in Equation (6).

$$RGDP_{it} = \widehat{\beta}_0 + \widehat{\beta}_1 RIN_{it} + \widehat{\beta}_2 REX_{it} + \widehat{\beta}_3 RCON_{it} + \varepsilon_{it} \qquad (6)$$

In accordance with this model, $\widehat{\beta}_0$ is used to interpret the difference of economic growth in the provinces, municipalities and autonomous regions. The Random Effects Model is given in Equation (7).

$$RGDP_{it} = \widehat{\beta}_0 + \widehat{\beta}_1 RIN_{it} + \widehat{\beta}_2 REX_{it} + \widehat{\beta}_3 RCON_{it} + u_i + \varepsilon_{it} \qquad (7)$$

E-VEWS3.1 statistical software can be used to evaluate the model for the 7 regions of China. The Fixed Effects weighted model is used in Formulas 4 and 5, and the results are shown in Table 8.

Table 8. Regressive Results of the Growth Rate of the Seven Regions of China (Fixed Effects)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RIN	0.350811	0.058011	6.047306	0.0000
RCON	0.481545	0.075467	6.380849	0.0000
REX	0.057822	0.026109	2.214657	0.0312
D03	-2.513962	1.010325	-2.488271	0.0161
Fixed Effects				
_North China--C	1.527005			
_Northeast--C	1.722291			
_East China--C	1.455100			
_South China--C	2.872081			
_Central China--C	1.200131			
_Southwest--C	1.445622			
_Northwest--C	1.476714			
Weighted Statistics				
R-squared	0.785411		Mean dependent var	11.07464
Adjusted R-squared	0.744144		S.D. dependent var	4.396982
S.E. of regression	2.224091		Sum squared resid	257.2222
Log likelihood	-131.4971		F-statistic	63.44127
Durbin-Watson stat	1.737576		Prob(F-statistic)	0.000000
Unweighted Statistics				
R-squared	0.653089		Mean dependent var	10.45175
Adjusted R-squared	0.586376		S.D. dependent var	3.474558
S.E. of regression	2.234615		Sum squared resid	259.6621
Durbin-Watson stat	1.836033			

The regression model indicates that it is helpful for data simulation and that the values of T and F have been tested. Meanwhile, the dummy variables of the year are also tested and in agreement with the actual variables. This means that there is certain inflation in China in 2003.

When the Random Effects model is used, the results are in table 9.

Table 9. Regressive Results of the Growth Rate of the Seven Regions of China (Random Effects)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.693306	0.849771	3.169448	0.0024
RIN	0.278785	0.055007	5.068148	0.0000
RCON	0.446936	0.066375	6.733461	0.0000
REX	0.067495	0.024791	2.722618	0.0085
D03	-1.800423	1.060527	-1.697669	0.0949
Random Effects				
_North China--C	0.089488			
_Northeast--C	0.020139			
_East China--C	0.450829			
_South China--C	-1.986322			
_Central China--C	0.831084			
_Southwest--C	0.423451			
_Northwest--C	0.171330			
GLS Transformed Regression				
R-squared	0.600220	Mean dependent var		10.45175
Adjusted R-squared	0.572649	S.D. dependent var		3.474558
S.E. of regression	2.271392	Sum squared resid		299.2350
Durbin-Watson stat	1.559476			
Unweighted Statistics including Random Effects				
R-squared	0.509682	Mean dependent var		10.45175
Adjusted R-squared	0.475867	S.D. dependent var		3.474558
S.E. of regression	2.515476	Sum squared resid		367.0019
Durbin-Watson stat	1.271519			

In the Random Effects Model, u_i and ε_{it} are both disturbance terms. In the quantitative analysis, Hausman's test is often used to decide which is more effective, Fixed Effects or Random Effects (Hadri, & Larsson, 2005; Jung, Shin, & Oh, 2005; Hausman, 1978). The test formula is as follows:

$$H=\chi^2[K]=[b-\beta]'\hat{\sum}^{-1}[b-\beta]\text{; in which }\hat{\sum}=\text{Var}[b]\text{-Var}[\beta]\text{;}$$

As for models 7 and 8, H is subject to the Chi-squared distribution with 2 as the degree of freedom. The critical value of Chi-squared with 2 as the degree of freedom is 5.99. If H>5.99, the Fixed Effects model is accepted; otherwise the Random Effects model is accepted. B is the evaluated coefficient of Fixed Effects, while β is the evaluated coefficient of Random Effects. The model is selected in accordance with the Hausman Test by means of STATA8.0 as given in Table 10.

Table 10. Selecting the Model in accordance with the Hausman Test

	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
Variables	Fixed Effects Model	Random Effects Model	Difference	S.E.
RIN	.3566695	.3254769	.0311926	.0245958
RCON	.4509177	.4510272	-.0001095	.0273331
REX	.0580146	.0620471	-.0040324	.0091845
D03	-2.321554	-2.117056	-.2044976	.2851598

b = consistent under Ho and Ha; obtained from xtreg,

B = inconsistent under Ha, efficient under Ho; obtained from xtreg,

Test: Ho: difference in coefficients not systematic

chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)= 1.66

Prob>chi2 = 0.7973

The results of test cannot reject a null hypothesis, which indicates that the Random Effects model is more suitable for this study.

5 CONCLUSION AND DISCUSSION

There are some similarities between the conclusions of this research and the evaluated results made by other scholars by means of traditional theories of economic growth, that is, there is a common ground of economic growth inside the economic belts. What differs from those scholars in this work is that there is little difference in economic growth between different economic belts. Our work greatly diverges from other works in the definition of model interpreting variables and reasonable interpretations. It does not only merely demonstrate the use of the Panel Data Model but also demonstrates the difference between different economic belts. The findings indicate that China was greatly affected by the Asian Financial Crisis in the years 1997-1999. There was certainly inflation in 2003. This paper tries to make two points clear: (1) it is effective to use the Panel Data Model to interpret the differences of economic growth in China, and using reasonable, scientific methods leads to making correct conclusions; and (2) the simulation results indicate that there are differences in economic growth between economic belts in China. According to the elasticity analysis of the impact of material capital and human capital on economic growth rate in the years 1995-2004, the output elasticity of material capital in the economic regions of China is higher than that of export demand, which indicates that increasing the input of material capital is more effective in the short term. However, the output elasticity of material capital and export demand is relatively advantageous in some regions.

The problems on which this paper needs to make further study are also very important. First, in the years 1994-2003, Chinese export trade was in a period of high-speed development, and spatial change and expansion of the samplings may have had certain effects on the conclusions. This indicates that the export demand had a great impact on economic growth during this period. Second, the last part of the paper examines the Hausman test on the Fixed Effects and Random Effects of the Panel Data Model, which is quite important for the correct selection of models and analysis. However, the analysis on dummy variables including time needs further extension, which will provide more detailed interpretation on finalizing the driving effect of export trade over the economic growth of a country.

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